

What is claimed is:

1. A method for operating an injection valve of an internal combustion engine (100), whereby the metering of fuel is adjustable not only by varying the injection time, but also by varying the stroke of the nozzle needle of the injection valve (120), comprising the following steps:

a) The internal combustion engine (100) is monitored for proper functioning (Sa);

b) A jammed-open operating state of the nozzle needle of the injection valve (120) is detected, due to soiling in particular, whereby the nozzle of the injection valve (120) cannot be closed any further by the nozzle needle, but it can be opened further (Sb); and

c) The nozzle is scavenged with fuel by setting an essentially maximum stroke of the nozzle needle to remove the soiling (Sc).

2. The method as recited in Claim 1, wherein, in step a), the internal combustion engine (100) is monitored to detect a richer air-fuel mixture (Sa1) and, in step b), the jammed-open operating state is detected when the richness of the air-fuel mixture is greater than a specifiable threshold value for richness, or the gradient of the enrichment is greater than a specifiable gradient threshold value for enrichment (Sb1).

3. The method as recited in Claim 1 or 2, wherein, in step a), the internal combustion engine (100) or a single cylinder of the internal combustion engine (100) is monitored – possibly in addition – to detect misfires (Sa2), and, in step b), the jammed-open operating state is – possibly also – detected when the number of detected misfires of a cylinder per unit of time exceeds a specified threshold value for frequency (Sb2).

1 4. The method as recited in Claim 1 or 2 or 3,
2 wherein, in step a) the pressure in one of the fuel accumulators (110) assigned
3 to the internal combustion engine (100) is monitored (Sa3) – possibly in addition
4 – and that, in step b), the jammed-open operating state is – possibly also –
5 detected when the pressure in the fuel accumulator (110) falls below a
6 specifiable threshold value for pressure, or when the course of the pressure in
7 the fuel accumulator (110) over time deviates from a specifiable, expected
8 course of pressure over time by more than specifiable tolerance values for
9 pressure (Sb3).

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11 5. The method as recited in one of the preceding Claims,
12 wherein, while scavenging is carried out according to step c), the duration of
13 actuation t_i , during which time the maximum nozzle needle stroke is set, is
14 reduced to the point that the fuel injected by the injection valve (120) into the
15 combustion chamber of the internal combustion engine (100) does not exceed a
16 specified mean fuel value (Sd1).

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18 6. The method as recited in one of the Claims 1 – 4,
19 wherein, while scavenging is carried out according to step c), a combustion
20 misfire is artificially induced in the cylinder in which the jammed-open operating
21 state of the nozzle needle was detected, by delaying the moment of ignition for
22 this cylinder until the air-fuel mixture in the combustion chamber is no longer
23 flammable and/or until the high-pressure efficiency of combustion is minimal
24 (Sd2).

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26 7. The method as recited in one of the Claims 1 – 4,
27 wherein, when the internal combustion engine (100) operates in an
28 homogeneous operating condition, the moments of ignition are delayed—while
29 scavenging is carried out according to step c)—to the point at which the ignition
30 timing efficiency is adjusted according to the following formula (Sd3):
31

$\eta_{zw} = (M_{d_soll} / M_{i_opt}) \cdot (1/\eta_{\lambda})$,
 $\eta_{\lambda} = f(\lambda)$, $\lambda = r_l / r_{k_soll}$; and
 $r_{k_soll} = f(\text{scavenging stroke})$

wherein

η_{zw} is the ignition timing efficiency;

M_{d_soll} is the target value for the engine torque and/or for the internal combustion engine (100);

M_{i_opt} is the optimum engine torque and/or the optimum torque of the internal combustion engine (100);

η_{λ} is the λ efficiency;

r_l is the air mass; and

r_{k_soll} is the target value for the fuel mass.

8. The method as recited in one of the Claims 1 – 4, wherein, when the internal combustion engine (100) operates in the stratified-charge mode, before or after the scavenging is carried out according to step c), at least a few of the generally numerous fuel injections designed to take place during a single multiple-injection cycle are not carried out (Sd4).

9. The method as recited in one of the Claims 1 – 8, wherein, the maximum stroke of the nozzle needle according to step c) is adjusted for only one cylinder of the internal combustion engine (100) and for only a few injection processes.

1 10. The method as recited in one of the Claim 9,
2 wherein the execution of step c) is blocked for a specifiable period of time before
3 it is allowed to continue (Se).

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5 11. A computer program for a control device (130) of an internal combustion
6 engine (100) with program code that is suitable for executing the method as
7 recited in one of the Claims 1 – 10 when it runs on a computer or
8 microprocessor.

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10 12. The computer program as recited in Claim 11,
11 wherein the program code is stored on a computer-readable data carrier.

12
13 13. A control device (130) for controlling an injection valve (120) of an internal
14 combustion engine (100), whereby the injection valve (120) is configured such
15 that fuel supplied by said injection valve is capable of being metered into the
16 combustion chambers of the internal combustion engine (100) by varying the
17 stroke of the nozzle needle of the injection valve (120),
18 wherein, with the aid of the control device (130), a jammed-open operating state
19 of the nozzle needle of the injection valve (120) is detectable, in particular due to
20 soiling of the nozzle, and, in this case, an essentially maximum stroke of the
21 nozzle needle is adjustable by the control device (130) for scavenging the nozzle
22 with fuel.

23
24 14. An internal combustion engine (100) with an injection valve (120) for
25 injecting fuel, whereby the injection valve (120) is configured such that it enables
26 metering of an amount of fuel supplied by it into the combustion chambers of the
27 internal combustion engine (100) by varying the stroke of the nozzle needle of
28 the injection valve (120),
29 wherein a control device (130) is assigned to the internal combustion engine
30 (100), with the aid of which a jammed-open operating state of the nozzle needle
31 of the injection valve (12) is detectable, due to soiling in particular, and, with the

- 1 aid of which said control device a substantially maximum stroke of the nozzle
- 2 needle is adjustable in this case for scavenging the nozzle with fuel.
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